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SOURCE Elektrichestvo, No 7, 1950, pp 54-58.ECONOMIC ASPECTS OF POWER FACTOR IMPROVEMENT

[This report, in three sections, consists (1) of a foreword to
 Lobanov's article, "Economic Aspects of Power Factor Improvement,"
 by the editors of Elektrichestvo, (2) a summary of the article by
 Lobanov, and (3) an abstract of an article by I. M. Kamen' on the
 same subject.]

Foreword

The economic aspects of power factor improvement are most important. In the past 7 years, a realistic scale of bonuses and surcharges did much to achieve improvement and drew the attention of industrial enterprises to the importance of economic consumption of electric power and the necessity for intraplant efficiency. However, this scale was in some cases inappropriate and this impaired the most economic use of electrical equipment and power. The present economic system of bonuses and surcharges is still not entirely satisfactory. A scientifically based method of reactive power cost accounting is long overdue. A reduction in reactive power consumption must be achieved in the general interests of the national economy and is particularly important at present, when the USSR is proceeding with the further construction of electric power stations and the development of complex power systems.

The article below requires careful consideration. The editor invites readers to take an active part in the discussion of this problem so that the Ministry of Electric Power Stations USSR may use the final results to solve the vital problem of increasing the power factor.

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Industrial enterprises working off the regional network are the main consumers of reactive power. Consumption of reactive power by industrial enterprises comprises approximately 60 - 70% of the total (excluding compensating units). The remaining 30 - 40% is used up in compensating for reactive power losses in the networks and transformers of the power systems themselves.

The size of the cables and the capacity of the generators and transformers are directly related to the power factor. The smaller the power factor, the larger the cables, transformers, and generators, and the larger the capital and material expenditure associated with them. Power losses in networks, generators, and transformers are also directly related to the power factor.

In calculating the net cost of electric power for a given power system, the estimated power factor at the consumer end is used. Deviation of the actual value of the power factor from the calculated value will imply an additional outlay if it is lower, or a corresponding profit if higher.

Various methods are used in tariff systems for penalizing the consumer with a low power factor or for reducing the cost of power for a consumer with a high power factor. Of these, the principal ones are:

1. Measurement of the maximum consumer load in kilowatts, from which is calculated the basic monthly cost of power independent of the actual power used (in this case the basic unit cost of power will be inversely proportional to the power factor).

2. Measurement of the reactive power supplied to the consumer, the cost being indicated by a reactive meter installed at the consumer end (in this case the payment for consumption at low power factor is charged mainly to consumers operating their equipment at full load most of the time, i.e., those with a large power requirement).

In existing electric power tariffs put out by the regional power systems of the Ministry of Electric Power Stations USSR, consumers causing a low power factor are penalized at a basic rate per kva of installed transformer capacity and, in addition, by the use of a special scale of bonuses or surcharges depending on the value of their power factor.

Although this system has led to a reduction in the demand for reactive power and an increase in the value of the power factor of consumer units, it has a number of defects, the principal of which are given below.

First, assessment of the basic cost is not made on the actual maximum power consumed as indicated by a maximum load meter but on the rated capacity of the transformers. This does not ensure the proper and timely encouragement of consumers to reduce their load and increase their power factor.

A second defect in the existing rate schedule is the nonuniform rate reductions in the power factor ranges of 0.80-0.85, 0.85-0.95, and 0.95-1.0, which are, respectively, 0.5, 1.0 and 1.5 percent for each 0.01 increase in the power factor. This encourages consumers to overcorrect their power factor beyond the optimum value (0.9-0.92) for system stability.

Third, tariff systems are used at present as sanctions to be imposed on consumers who use their power inefficiently, and are not based on the cost accounting principle of charging for the additional active power required of the power system.

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Actually, the cost of reactive power for power systems and for the consumers' compensating equipment, such as static condensers, synchronous motors, and synchronous condensers, does not exceed 10 - 20% of the cost of active power.

Suitable scales of bonuses and surcharges based on the actual cost price of reactive power would encourage consumers to select more suitable compensation methods and equipment, and would lead to maximum economy in expensive active power.

The following specific measures should be included when the new tariffs are worked out:

1. Levy of a basic charge on the consumer per kva of maximum consumer load and not per kva of rated transformer capacity. Change-over to this system would require the installation of maximum load meters such as are at present being produced by Lenenergo (Leningrad Power System).

2. Modification of the bonus and surcharge rates for different values of the power factor, so as to give consumers the maximum encouragement to increase the power factor to the optimum for the power system.

3. Payment of bonuses to all consumers with a power factor of more than 0.75 - 0.8.

4. Adjustment of the rates of bonuses and surcharges to a scale commensurate with the economic importance to the national economy of increasing the power factor. Fines for inefficient management should be imposed by state inspectors for industrial power and power supervision of the Ministry of Electric Power Stations USSR and should be made independent of the normal monthly charges for electric power.

Finally, besides ensuring that consumers pay the right amount for electric power, the tariff system must take all types of power consumption into account and be easy for the consumers to understand. The main point is to ensure the maximum economy in electric power, in which increasing the power factor and other measures for improving the efficiency of the equipment of consumers and power systems play an important part.

* * *

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This article describes a system for calculating the fine to be imposed on a consumer for uneconomical consumption of active power, leading to a great demand for reactive power. Its intention is to convince the consumer that the fine he pays is not a penalty imposed haphazardly for waste, but is a technical-economical measure based on scientific calculation.

It is recommended that reactive power meters should be installed and used as a basis for surcharges. In this way, any encouragement to the consumer to overconsume active power would be eliminated.

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